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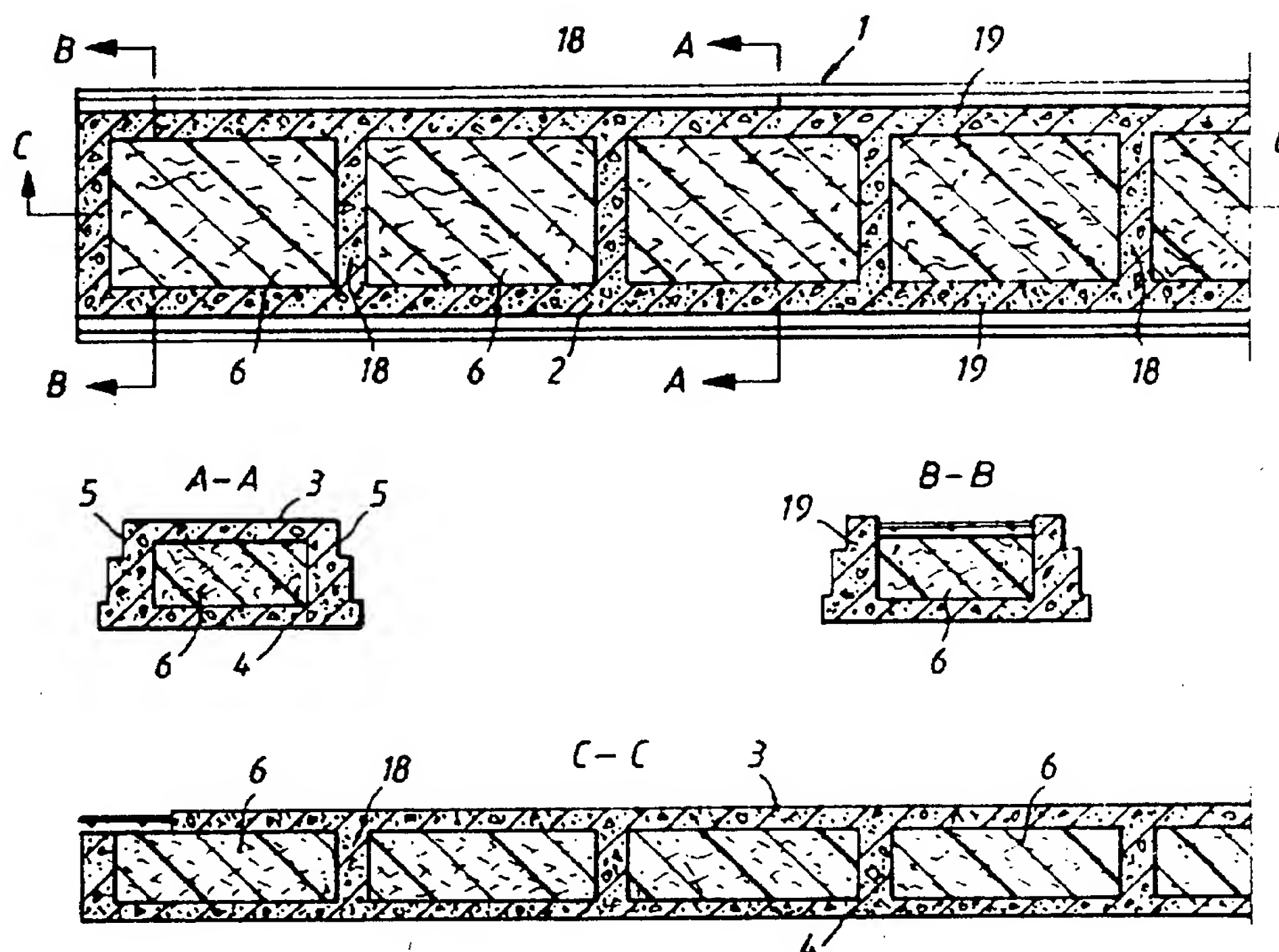
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(54) Title: FLOOR COMPONENT AND METHOD OF MANUFACTURE THEREOF



(57) Abstract

The invention relates to a floor element (1) of concrete (2) intended to be prefabricated and which in its inner parts contains spare bodies (6) of considerably lighter material than concrete. The element (1) comprises one in the longitudinal direction, on the upper surface (3) and on the bottom surface (4), equal and upwards directed cumbering determined by a constant cumbering radius (10).

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Floor component and method of manufacture thereof

Floor structures to multy story buildings like offices, appartment houses etc are normally made of concrete either as on site cast floors or as prefabricated floor elements.

Floor structures cast on site imply a not very rational construction method, a big labour force requirement, weather dependent and a long time for drying all moisture bound up during the casting.

Normally the casting is done in two steps. First the load bearing deck is casted. Later on when the building has got roof and walls a top casting is done which is needed as a base for the flooring. Sometimes the casting to a finished surface can be done in one and the same casting (one step casting). This, however, put big requirements on planning, workmanship and the weather conditions. A rain can completely destroy the surface.

Building with elements implies a rational and faster way of construction. In Sweden and in many other countries the most common element type to floor is so called hollow core elements. These consist of concrete elements of some lenght with longitudinal holes in the middle of the element height. The function of the holes is primarily to save material and limit the weight with a preserved total structural height and thereby keeping mainly the same load bearing capacity and stiffness.

The hollow core concrete elements are produced very rational in a longish continuous casting process where a wagon automatically is moved forwards on a casting bed. The wagon delivers concrete, forms the elements and creat-

es the holes. Afterwards a cutting to desired element lengths is done.

For elements with longer span prestressed reinforcements are used. This prestressing automatically gives the elements a precumbersome. For longer spans a precumbersome also is required as compensation for the deflection due to the dead weight and the load on the elements.

The precumbersome through the prestressing however, often becomes rather uncontrolled. This can result in that two elements placed side by side get a different precumbersome. Especially noticeable is this when an element is cut or when elements of different length are placed side by side. This often results in time consuming adjustment works as loading or alternatively propping of elements to get these to the same level before casting of the joints between the elements can be done.

An other drawback with hollow core concrete elements is an on the whole less good measure accuracy. This together with the above mentioned problem with the precumbersome results in the need of relatively thick layers of top concrete to obtain the necessary smoothness and finishing as a base for the flooring. This takes away some of the intended advantages of element construction because the top concreting take times and again large amount of moisture is added.

In the same way as for on site casted floor the top concreting often has to be done after that the building has got roof and walls. Filling the joints between the elements with concrete however has to be done already during the erecting due to the fact that the floor normally is used for stabilizing the building. Before the elements have been joint this stabilizing capacity is lacked.

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An other drawback with this element type is the difficulties to afterwards take up larger holes for instance to shafts or similar. This is due to the fact that the reinforcement then is cut and thereby the load bearing capacity is at risk.

Compared with a conventionally on site casted floor structure it is also difficult to obtain the same toughness and continuity as will be obtained for the on site casted floor structure. Special joint reinforcement or other arrangements are normally required to secure the building against progressive collaps.

Lately information also have been brought forward which indicate that the elements in certain applications can get a large reduction of the shear force capacity with a reduced safety against shear collaps as a consequence.

The present invention consists of a prefabricated floor element of concrete with all the advantages of element construction but without the drawbacks pointed out above for hollow core elements. More over the design of the element and the joint procedure imply that the same toughness and continuity as for a conventionally on site casted floor can be obtained.

The invention will now be described in more detail with reference to the accompanying drawings, where

Fig. 1 shows a plane section, cross sections and a longitudinal section of a finished element,

Fig. 2 shows the principle for the casting and the mould design,

Fig. 3 shows the design of the longitudinal joints between two elements,

Fig. 4 shows the design of the end joint of the element,

Fig. 5 shows how a static composite function with a steel beam can be obtained,

Fig. 6 shows a division of a long mould in parts,

Fig. 7 shows an example how the precumbering of the mould can be obtained,

Fig. 8 shows examples of the design of the mould sides,

Fig. 9 shows examples of the design of the end stop and

Fig. 10 describes the principle for the production of an element.

With reference to fig. 1 is shown how the finished element 1 is built up of concrete 2 with a top surface 3, bottom surface 4 and two side surfaces 5 and in the concrete placed spare bodies 6 of considerably lighter material than concrete, for instance cellur plastic.

The element is not produced as a hollow core element in a continuous casting process but is casted according to fig. 2 up and down in a fix and upwards open mould 7. The casting in a fix mould gives a considerably greater measure accuracy. The bottom 8 in this mould as well as the upper edges 9 of the longitudinal sides have a downwards directed bending in form of a constant radius 10 in the order of 200-300 m. The downwards directed bending with a constant radius implies that the finished element 1 gets a precumbering the size of which is a function of the ele-

ments length or span. The precumbering as a function of the span for a radius of 250 m can be seen in the table

span (m)	precumbering (mm)
4	8
6	18
8	32
12	72

The choice of radius is adapted so that the shown precumbering roughly corresponds to the estimated deflection for the span in question due to the dead load of the elements. This results in that the elements after erection become mainly plane.

The advantage with a precumbering in the form of a constant radius also is that the same precumbering always will be obtained for the one and same element length irrespectively where in a long mould the element is produced. The result is, that the problem with different levels between elements placed side by side which where mentioned concerning the hollow core elements, will normally not arise even if two elements placed side by side would have different lenghts.

If in special cases still a certain difference in level would arise between two elements the longitudinal joint 11 between the elements is designed in such a way that a simple adjustment possibility exists in the form of hoops 12 cast into the joint.

By for instance providing the hoops with threads and use a steel plate 13 with holes corresponding to the hoops the elements easily can be adjusted to the same level with aid of nuts 14 which are screwed on the hoops 12.

The described adjustment arrangement is simple to obtain when producing the elements by casting in a fix mould but impossible or very difficult to obtain by the continuously hollow core element production. The arrangement can also be used to fix the elements to each other before the casting of the joints is done. This results in the elements, in contrary to hollow core elements, will act as a stabilizing slab even without the joints being casted. The casting of the joints thereby can be done in a later stage if wished.

With reference to fig. 1, fig. 2 and fig. 3 another very big advantage which can be mentioned is that the constant precumbering 10 together with a sufficient smooth upper surface obtained already when casting the element by casting the upper surface 3 downwards against a smooth mould bottom 8, results in that no top concreting on site is needed. Only the longitudinal joints 11 between the elements and the joints at the end of the elements have to be filled with mortar or concrete. Thereby the adding of a lot of water is avoided which a later top concreting will require.

The design of the joints in the end 15 of the element can be seen in fig. 4. The design implies that a bare reinforcement mesh 16 which is anchored in the element will be covered in concrete when casting the joints. This makes it possible to easily obtain a continuity with negative moments and thereby an increased load bearing capacity and stiffness by adding a rein-

forcement 17 above the support which is covered in concrete together with the bare mesh. Thereby an efficient anchoring to the elements is obtained. For hollow core elements this possibility to obtain a continuity over the support is lacking.

As is shown in fig. 5 the design of the end joints also implies that a very efficient static composite function easily can be obtained if the support is a composite beam by the element end joints 15 and the reinforcement mesh 16 and the reinforcement 17 respectively being efficiently casted together.

In order to give the floor element a larger stiffness and load bearing capacity also for longer spans a sufficient structural height is needed. For the present element a structural height of 300 mm has been chosen for the normal case. Light spare bodies 6 (fig. 1) have been put into the middle of the element so that the element shall not be too heavy. This results in that the element weight, with maintained loadbearing capacity and stiffness, will only be a little more than half of the weight of a homogenous concrete floor with the same height.

The spare bodies are arranged in such a way that a "cross beam system" is created (beams as well along as across the element). This gives the element a very high stiffness and more in general it is true that the high stiffness in relation to the weight compared with a homogenous floor with the same weight gives the element a very good sound insulation quality. Not at least the transverse beams 18 add to an increased stiffness across the element which is of value especially for the impact sound insulation.

The longitudinal beams 19 also have a pure static function by transferring shear forces from the tensile reinforcement in the bottom to the compressed plate in the top. To be able to transfer these shear forces a hoop reinforcement, or similar is needed in the longitudinal beams.

If the element joints (longitudinal and end joints) are casted in a later stage, which as pointed out is possible, the "check pattern" created by the joints can be used for putting in cables and smaller pipes.

Between the beams of the element, where the spare bodies are situated, holes can easily be taken up for shaft etc without the loadbearing capacity being at risk.

A convenient way to produce the elements is in a elongated mould 40-80 m with a bottom of steel on a vibrator table. The length is divided into a number of parts, where each part contains the before mentioned bending radius of 200-300 m (fig. 6). To take out the bending on the whole length of the mould would create too big differences in levels between the lowest and highest point. A convenient length of one part can be 20-30 m. This gives a difference in level of about 200 and 450 mm respectively.

The bending can for instance be obtained by making the legs 20, which support the mould bottom 8, with different heights corresponding to the bending radius (fig. 7).

A suitably normal element width is 1200 mm and the height 300 mm. The mould sides can be made of steel profiles 21 composed according to fig. 8. In the mould

sides holes 22 are made for casting the previous mentioned adjustment bars 12 into the element.

The end stops can be made up of steel profiles 23 according to fig. 9.

With reference to fig. 10 the very production can suitably be done as follows. The given measures etc shall be seen as examples and can vary within certain limits.

- a) In the mould end stops 23 are arranged corresponding to the element length and spare forms 24 are placed in order to make the reinforcement mesh 16 bare in the element ends.
- b) Reinforcement mesh 16, reinforcement hoops 25 and hoop bars 12 for the adjustment of the elements are arranged in the mould. Further spare forms 26 in order to make the reinforcement mesh bare in the element ends are put on top of the mesh.
- c) A first about 70 mm thick concrete layer 27 is casted in the mould and vibrated.
- d) Cellur plastic blocks 6 about 180 x 1500 mm are put into the mould on top of the recently casted first concrete layer 27.
- e) Reinforcement mesh 28 is put above the cell plastic blocks 6 and the remaining concrete 28 is casted. The upper surface (the finished elements bottom surface) is drawn to the desired smoothness. If possible the elements are heated for a quicker hardening.

- f) The elements are taken out from the mould 7 by lift hokes 30 in the end stops 23.

In fig. 11 a simplified alternative to conventionally shearforce reinforcement is shown in the form of reinforcement hoops (compare 25 in fig. 10b). Instead the reinforcement mesh 16 is being made wider and bent up along its longitudinal sides whereafter the reinforcement mesh 28 is connected to the bent mesh 16. In fig. 11 a is shown the proceedings at casting and in fig. 11 b the finished element in the turned right way.

CLAIMS

1. Floor element (1) of concrete (2) intended to be prefabricated, in its inner parts containing spare bodies (6) of considerably lighter material than concrete, **characterized** in that the element (1) comprises one in the longitudinal direction, on the upper surface (3) and on the bottom surface (4) equal and upwards directed precumbering determined by a constant cumbering radius (10).
2. Floor element (1) as claimed in claim 1, **characterized** in that the cumbering radius (10) is between 200 and 300 m .
3. Floor element (1) as claimed in any one of the preceding claims, **characterized** in that the top surface (3) is so smooth that no top concreting or leveling is needed but a flooring can be directly put on to the elements after the casting of the joints.
4. Floor element (1) as claimed in any one of the preceding claims, **characterized** in that in the longitudinal joint (11) special hoope bars (12) are casted which together with a steel plate (13) and nuts (14) makes it possible to easily adjust two side by side placed elements to level in height.
5. Floor element (1) as claimed in any one of the preceding claims, **characterized** in that the design of longitudinal joint (11) with hoope bars (12), steel plate (13) and nuts (14) results in that the elements act as a stabilizing slab even before casting of the joints.

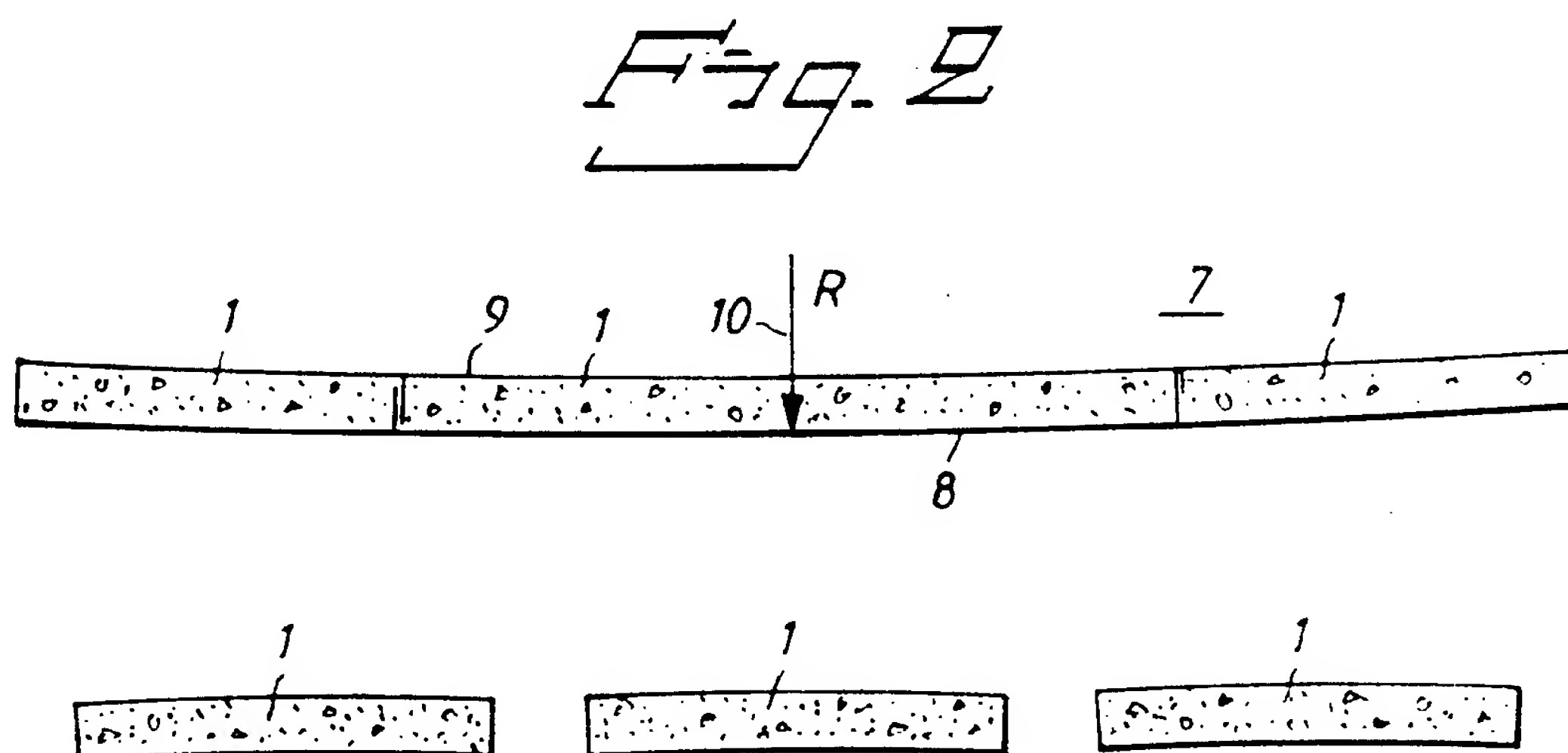
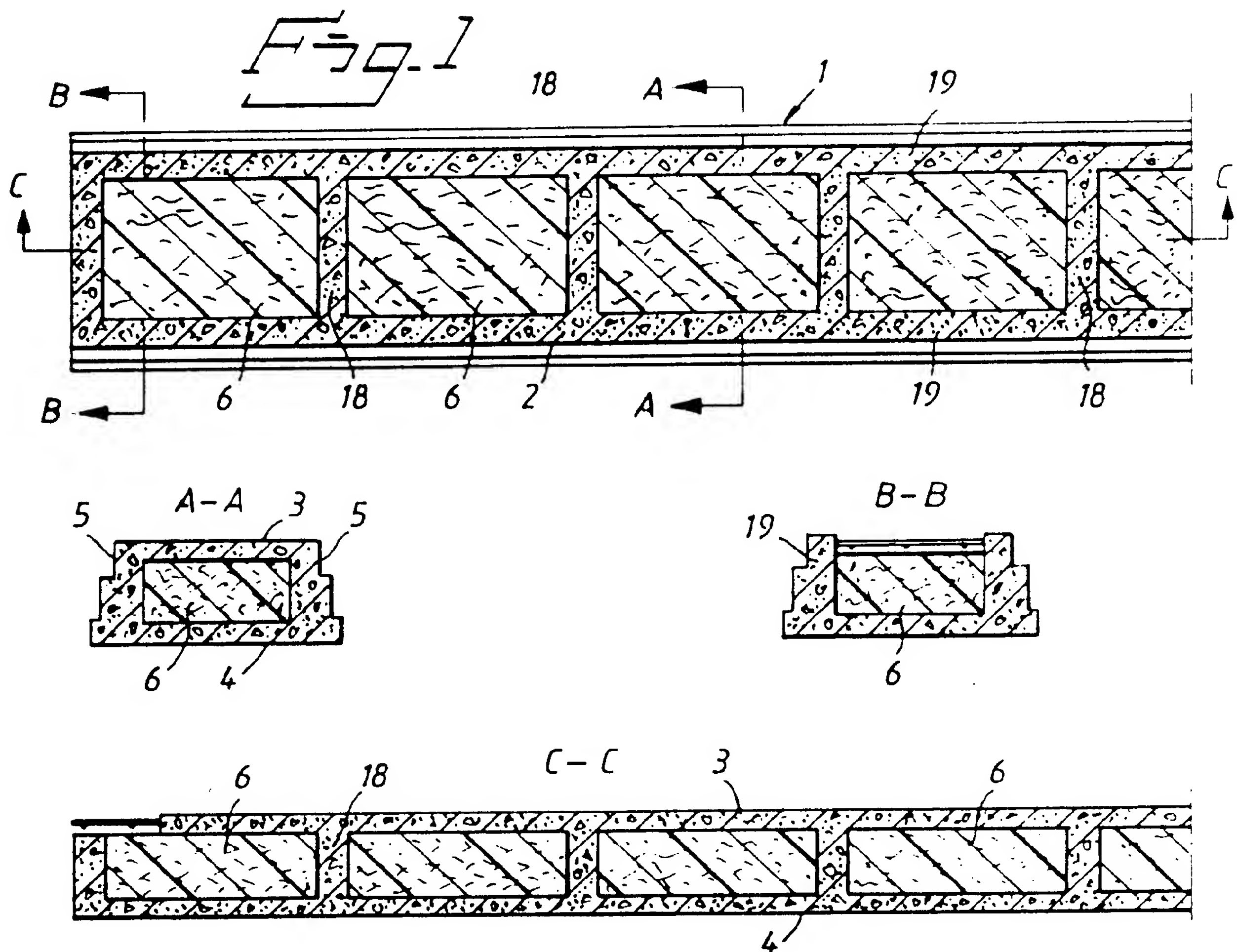
6. Floor element (1) as claimed in any one of the preceding claims, **characterized** in that the element ends have spares (15) and a bare reinforcement mesh (16) which makes it possible for the element to efficiently, statically cooperate with a composite beam by the on site placed reinforcement (17) being efficiently casted together with the beam and the reinforcement mesh (16).

7. Floor element (1) as claimed in any one of the preceding claims, **characterized** in that the required shear force reinforcement for transferring shear forces from the tensile to the compression side is achieved by that the longitudinal sides of reinforcement mesh (16) are bent and the ends are connected to the reinforcement mesh (28).

8. Method for producing of a floor element (1) of concrete (2) containing spare bodies (6) of considerably lighter material than concrete, **characterized** in that the element (1) is casted up and down in an upwards open mould (7), the bottom (8) and sides (9) of which comprise an equal and in the longitudinal direction downwards directed cumbering determined by a constant cumbering radius (10).

9. Method for producing of a floor element (1) as claimed in claim 8, **characterized** in that the cumbering radius (10) of the mould (7) is between 200 and 300 m.

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Fig. 3

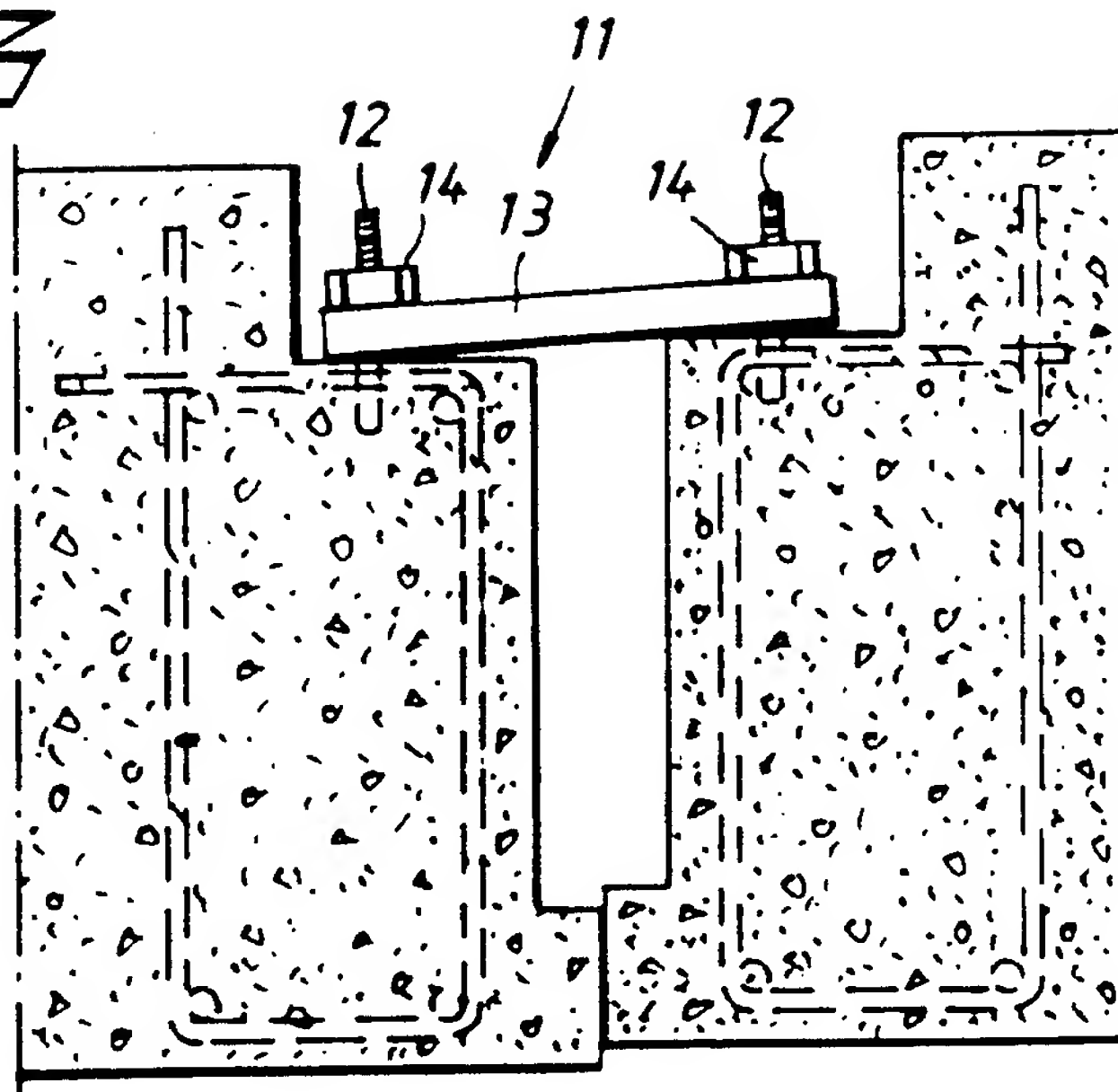


Fig. 4

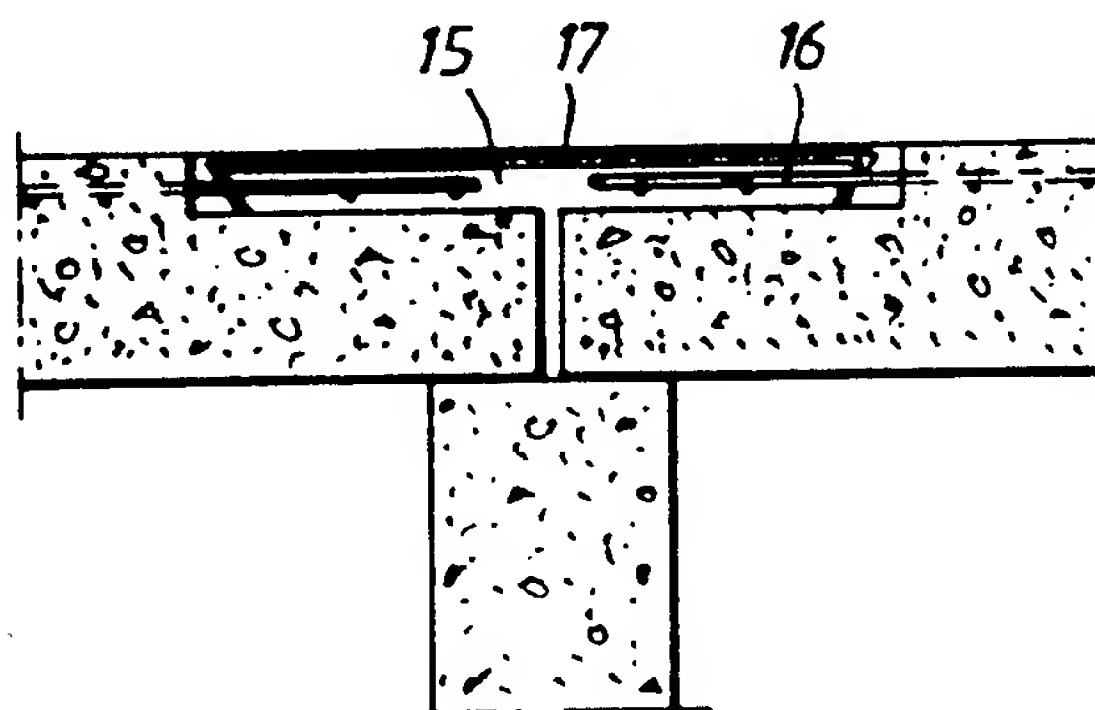
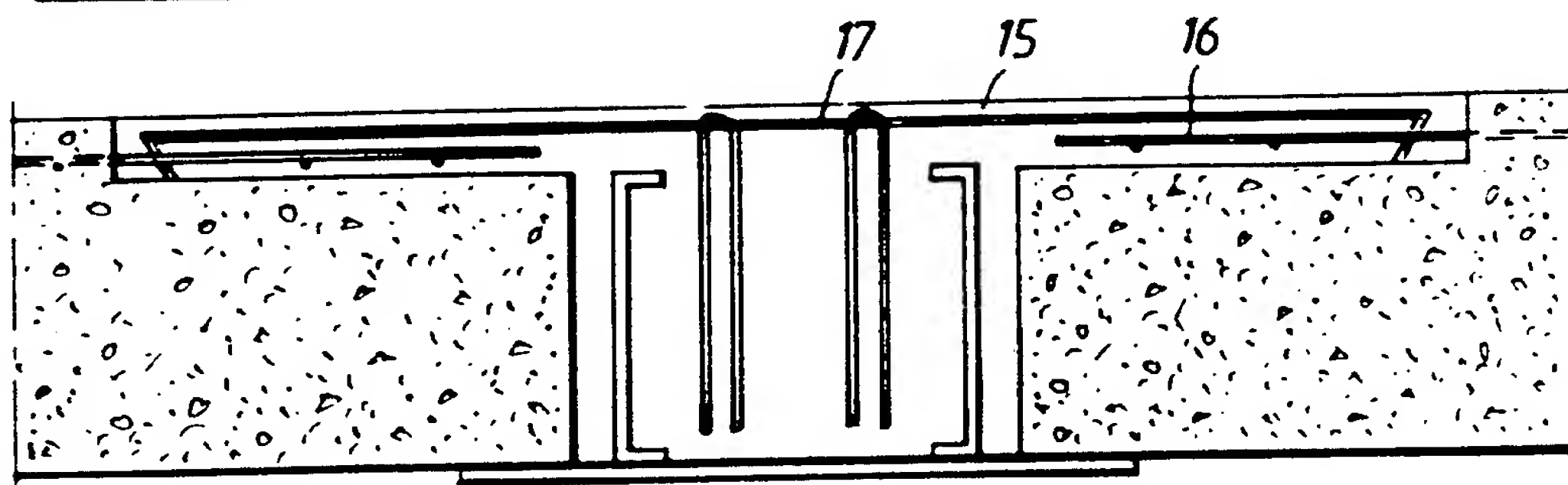


Fig. 5



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Fig. 6

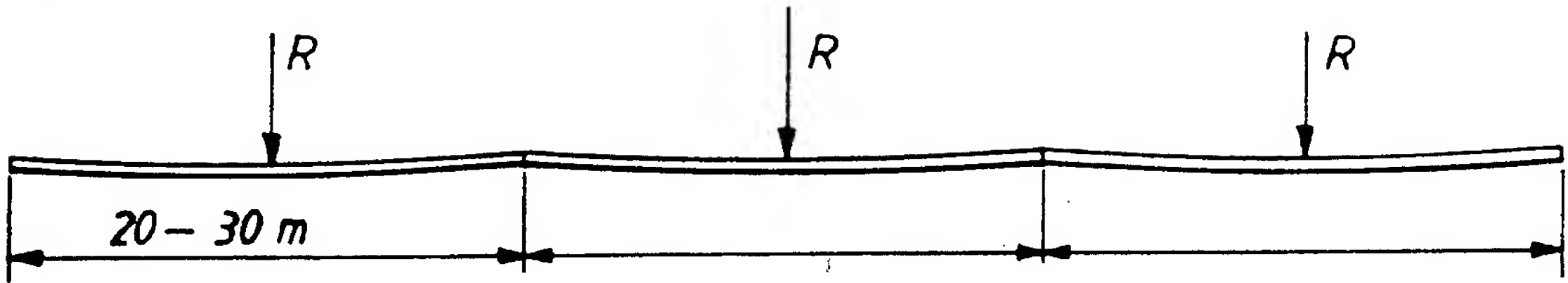


Fig. 7

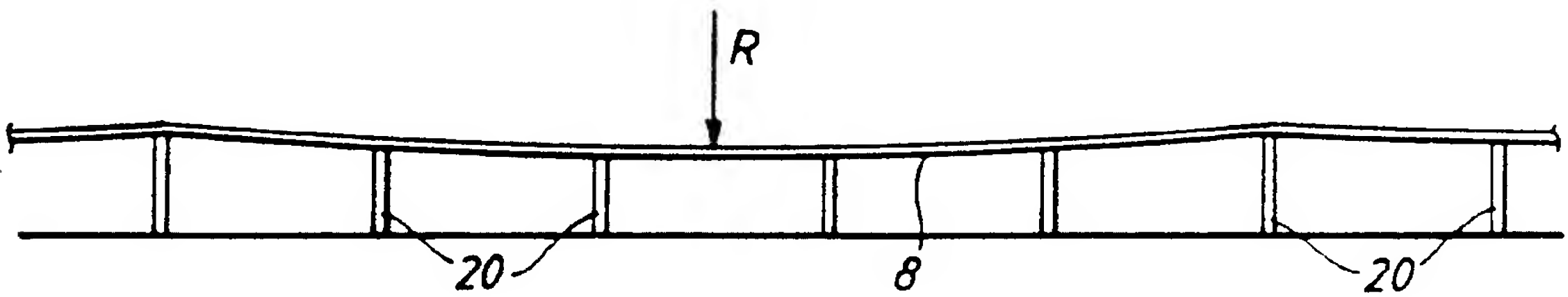


Fig. 8

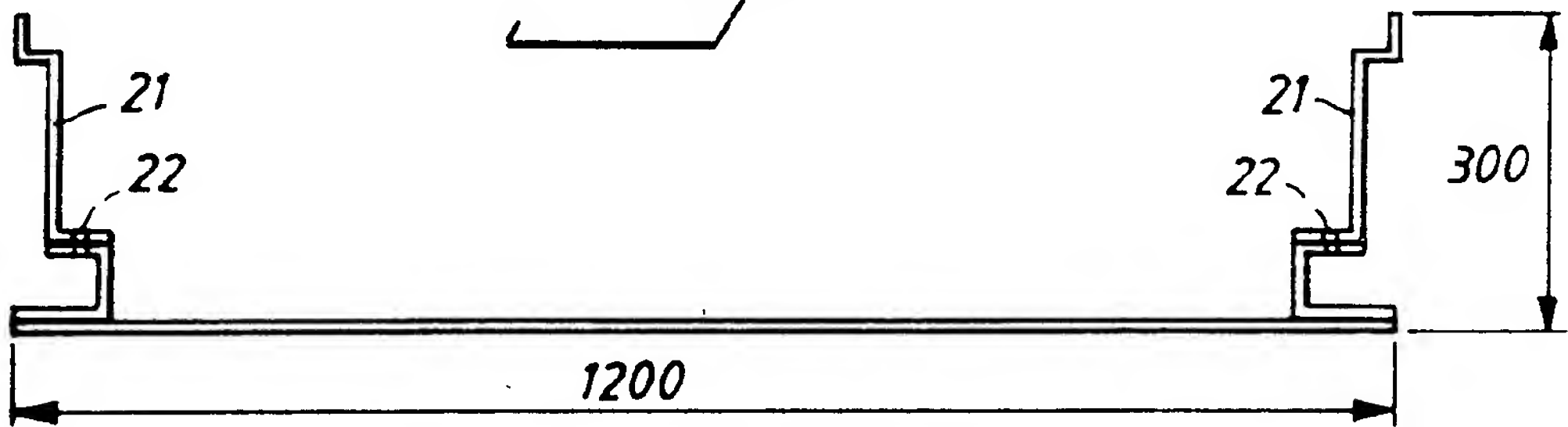
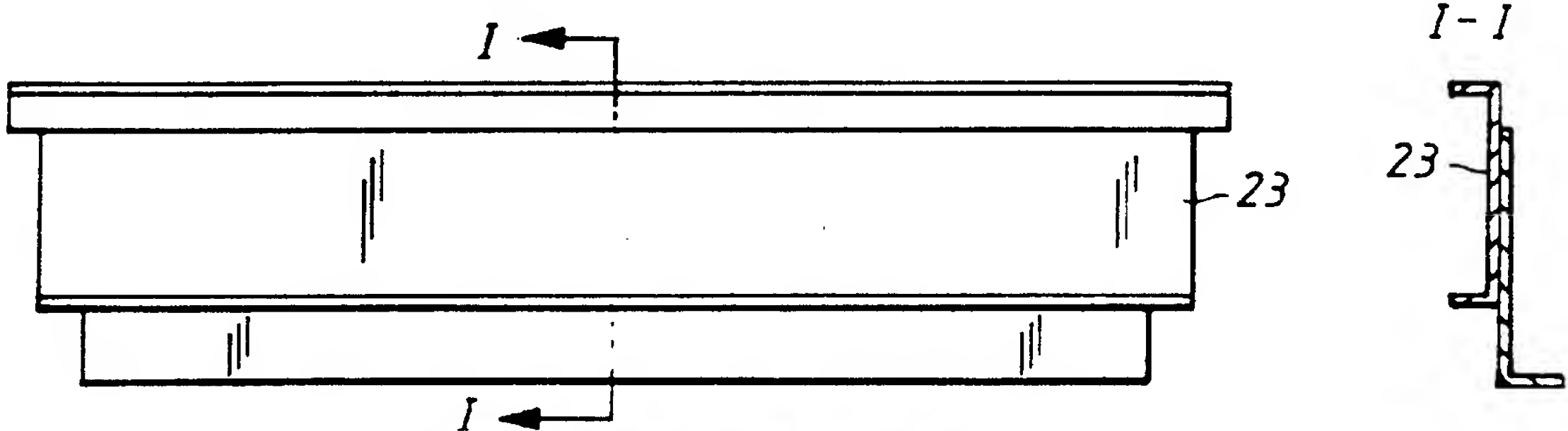
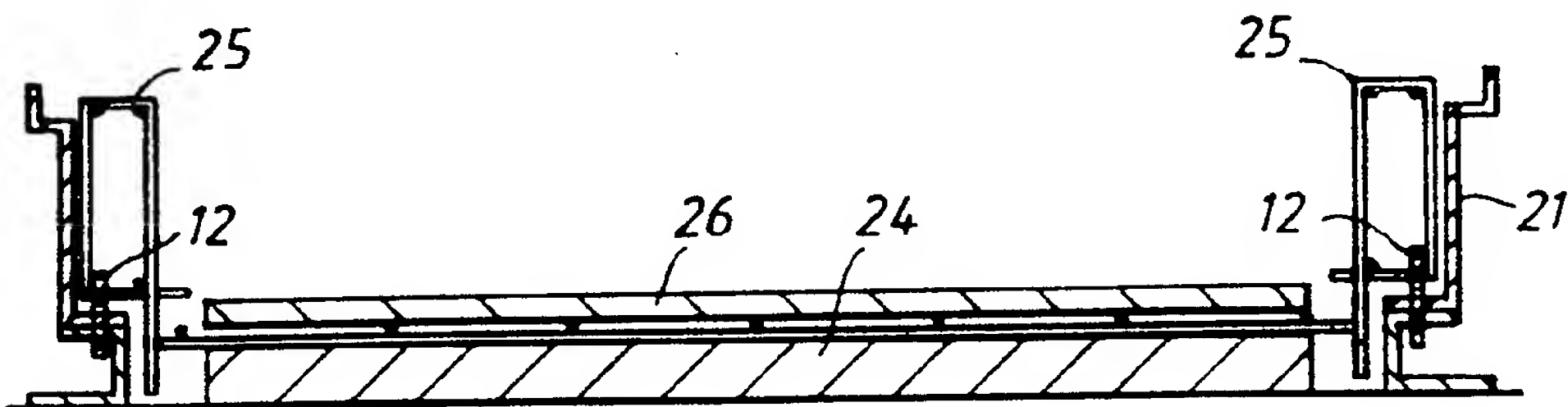
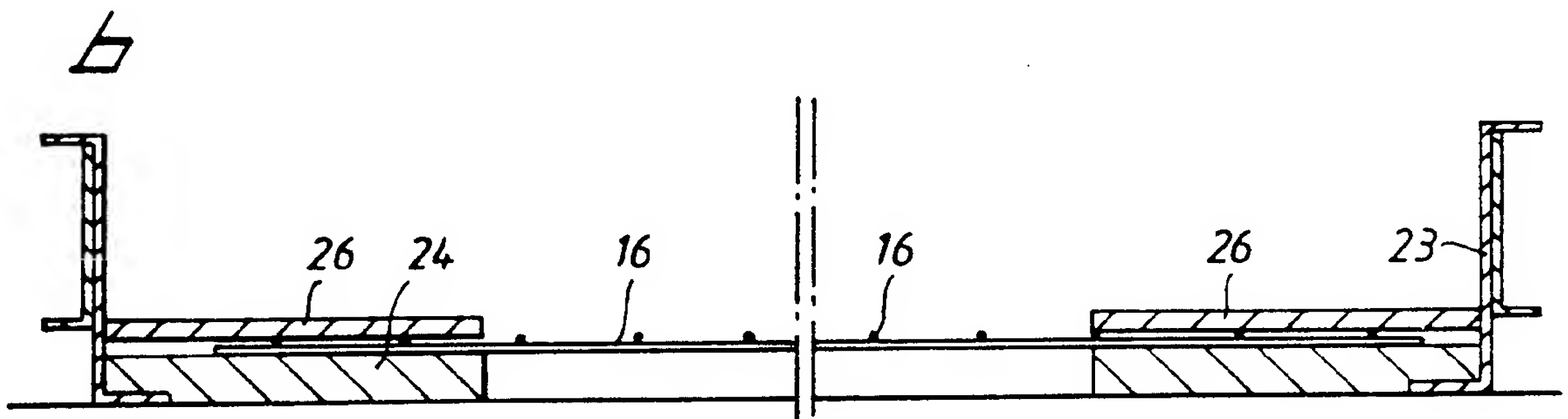
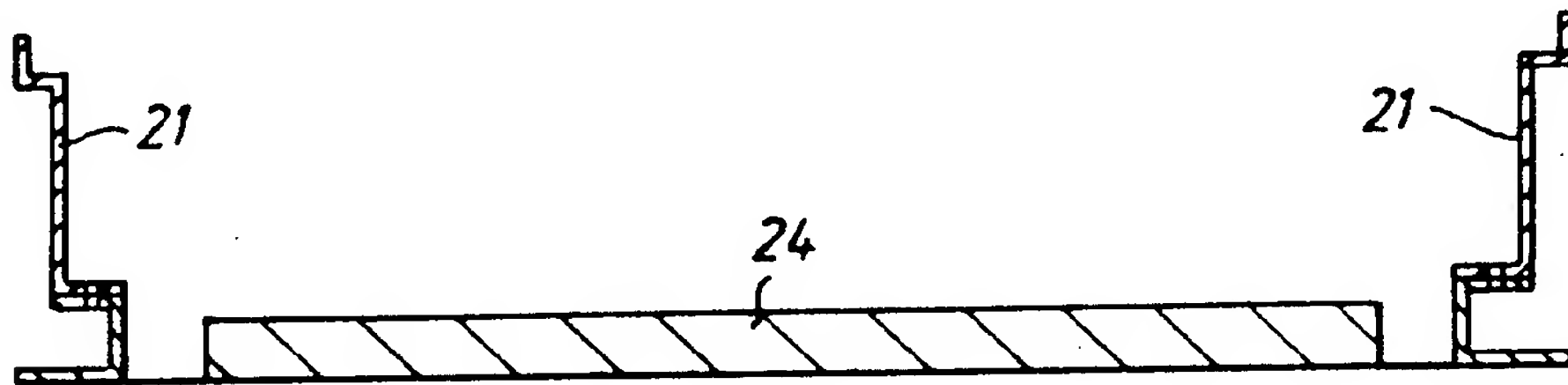
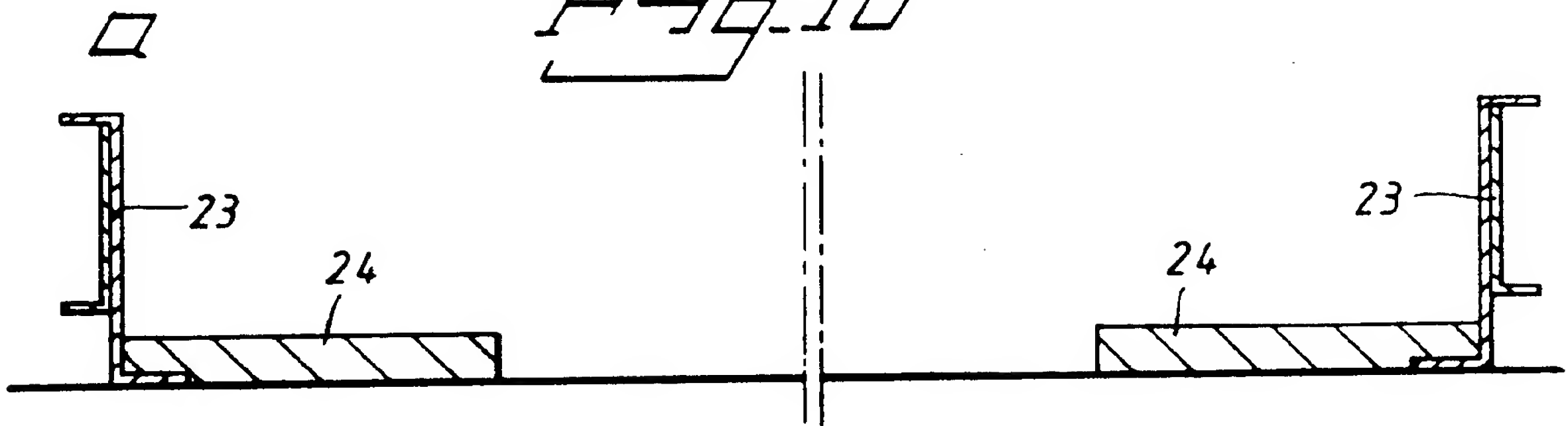


Fig. 9



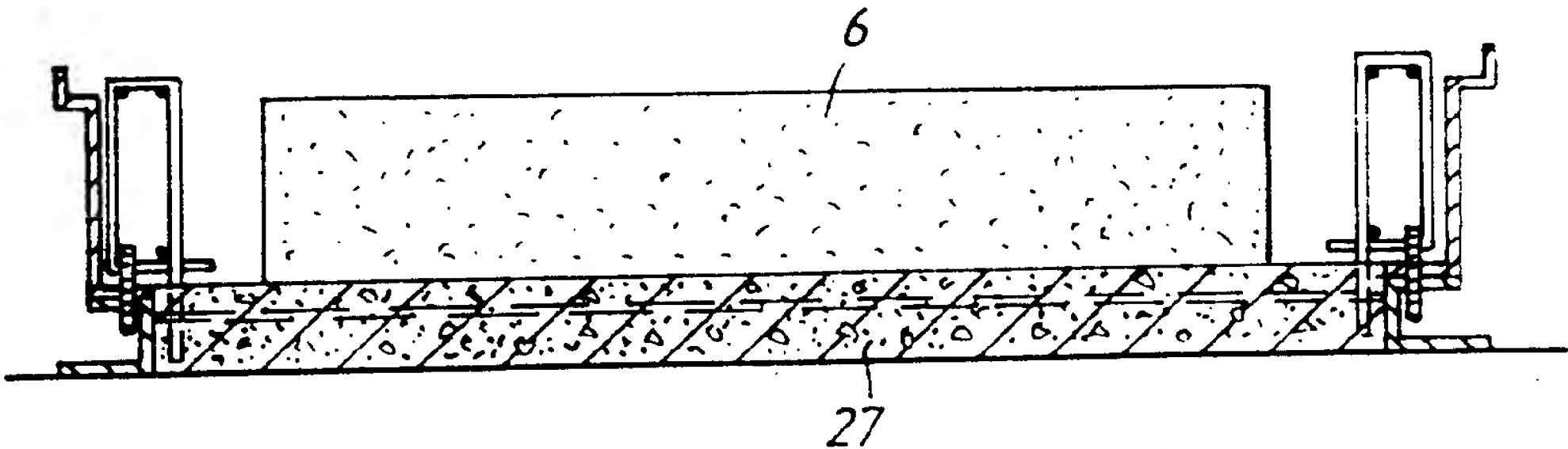
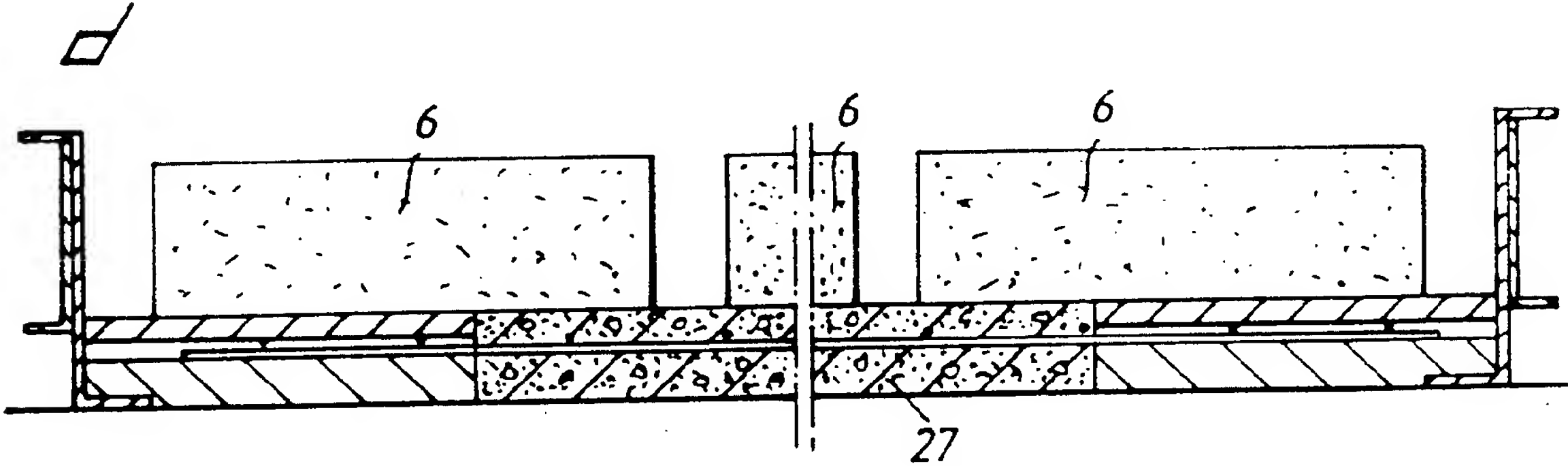
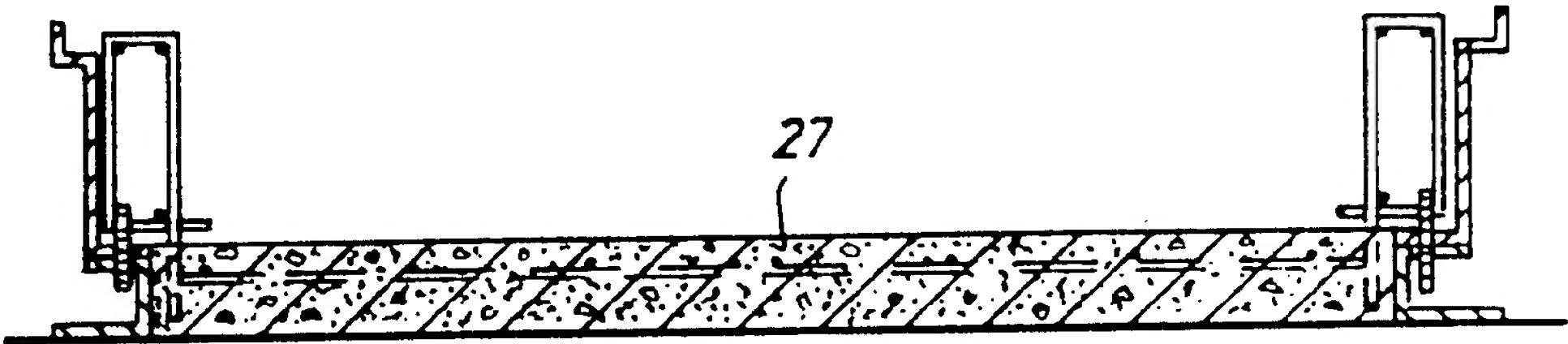
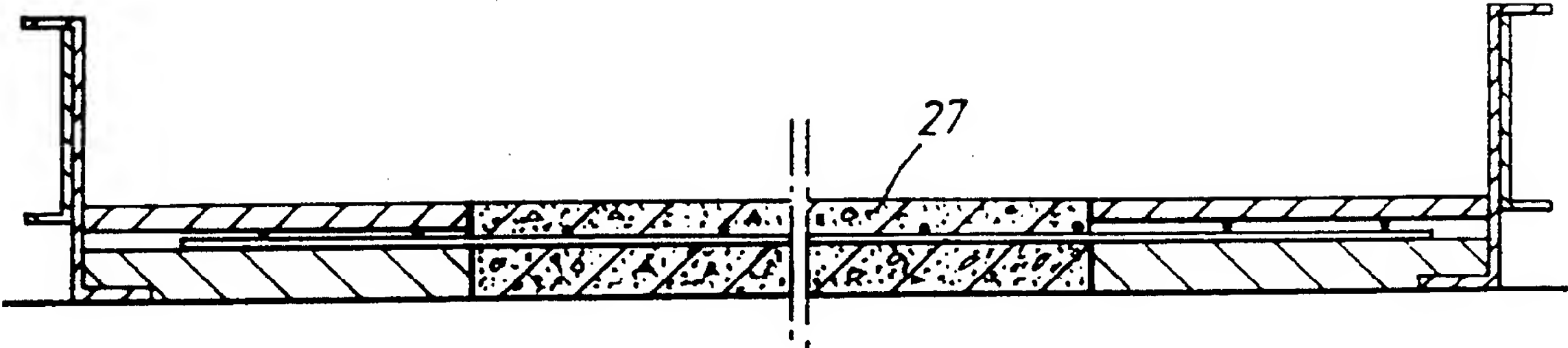
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Fig. 10



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Fig. 10



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Fig. 10

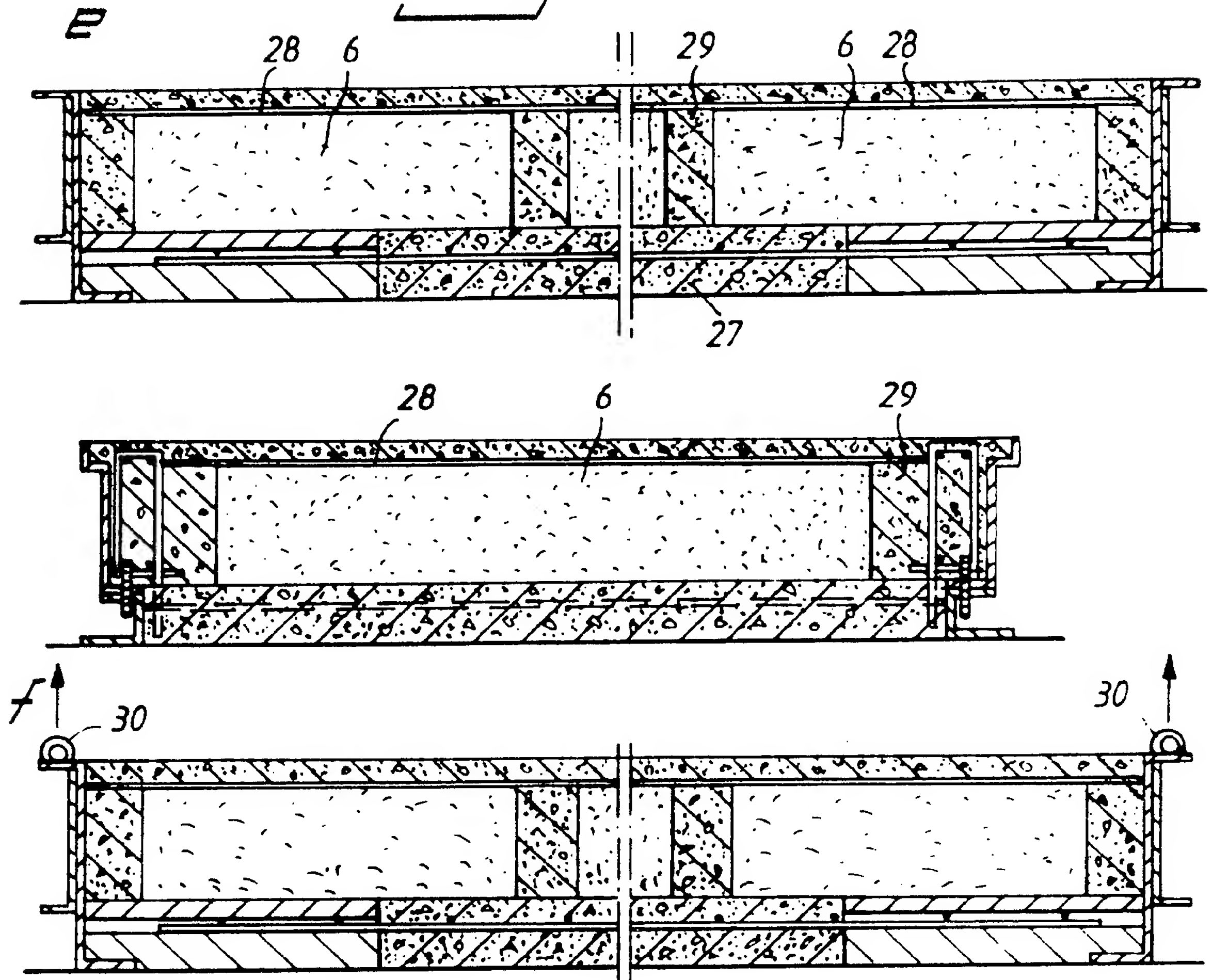
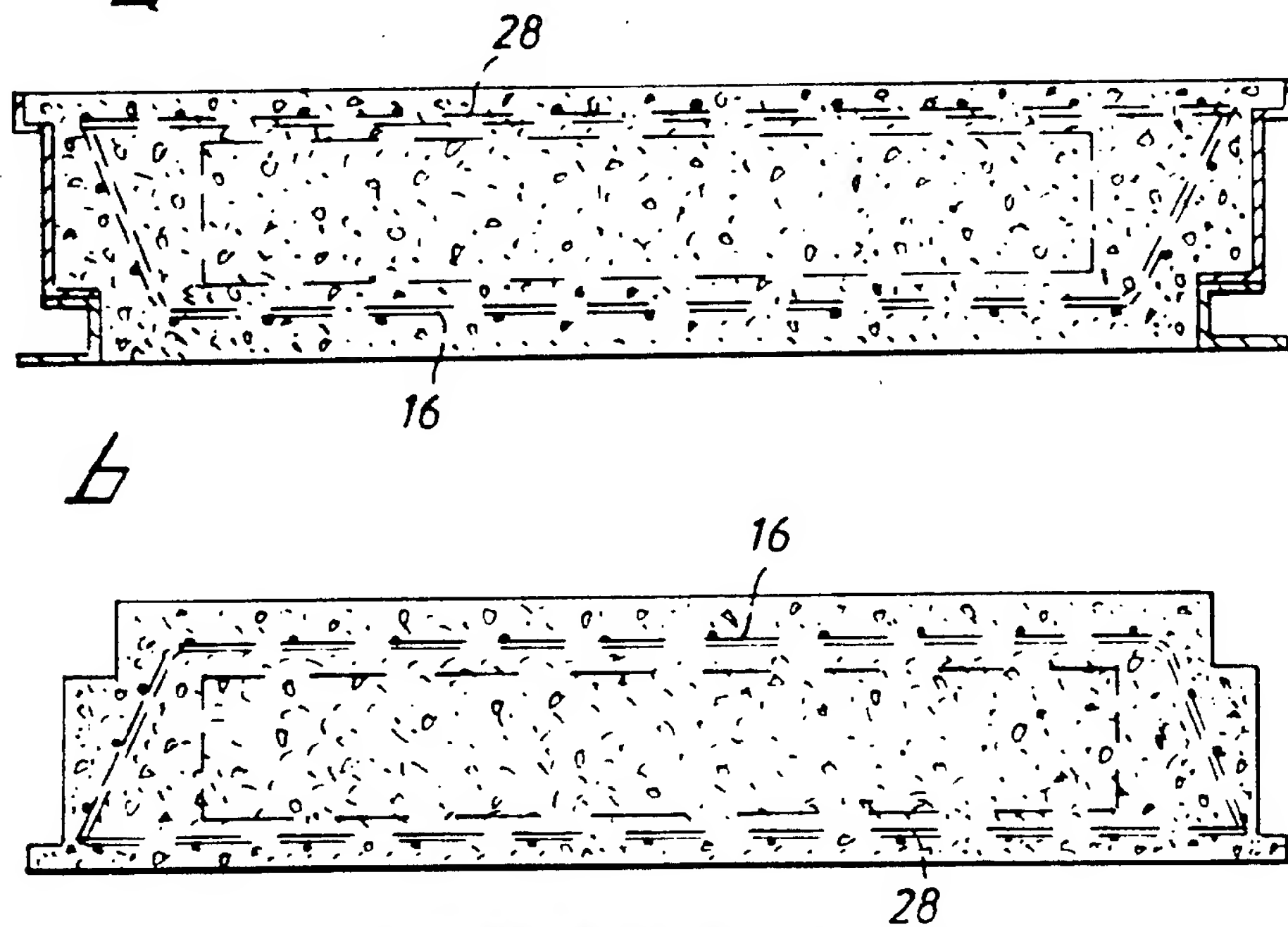


Fig. 11



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INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 93/01084

A. CLASSIFICATION OF SUBJECT MATTER

IPC5: E04B 5/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC5: E04B, E04C, B28B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DE, A1, 3031276 (KOCH GMBH BAU + BETON KG), 4 March 1982 (04.03.82), page 9, line 3 - line 25, figure 1 --	1,8
Y	EP, A1, 0000837 (TILLY, GRAEME JOHN), 21 February 1979 (21.02.79), page 8, line 18 - page 9, line 23, figures 5a-5e --	1,8
A	DE, C, 803427 (WILHELM TACKE ET AL), 2 April 1951 (02.04.51), figure 1, detail 5 --	1-9



Further documents are listed in the continuation of Box C.



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Date of the actual completion of the international search

7 March 1994

Date of mailing of the international search report

29 -03- 1994.

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INTERNATIONAL SEARCH REPORT

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US, A, 3372519 (G.C. RUSSELL), 12 March 1968 (12.03.68), figure 3, detail 54, figure 4, detail 72 --	1-9
A	US, A, 4030262 (A.C. DEAN), 21 June 1977 (21.06.77), figure 1, detail 16 --	1-9
A	US, A, 4219978 (B.R. BROWN), 2 Sept 1980 (02.09.80), figure 6, detail 100 -- -----	1-9

INTERNATIONAL SEARCH REPORT

Information on patent family members

28/01/94

International application No.

PCT/SE 93/01084

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DE-C- 803427	02/04/51	NONE	
US-A- 3372519	12/03/68	NONE	
US-A- 4030262	21/06/77	NONE	
US-A- 4219978	02/09/80	NONE	